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STEP

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TITLE: Reflection and transmission of a plane-parallel layer in the scope of non-linear optics

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TEXT: The subject of investigation is a plate of thickness l and of small luminance characterized by the absorption coefficient k_o and the [illegible] reflection coefficient on the face r. A luminous flux S_o is incident perpendicularly. Owing to multiple reflection there exist internally two kinds of flux at any point x: S_1 moving parallel to the incident flux, and S_2 moving in the opposite direction. These are described by the differential equations $dS_1 = -kS_1dx$, $dS_2 = kS_2dx$ (1) with the boundary conditions $S_{1(x=0)} = S_0(1 - r) + rS_{2(x=0)}$, $S_{2(x=l)} = rS_{1(x=l)}$ (2). The absorption coefficient can be expressed by $k = k_o/1 + \alpha(S_1 + S_2)$, where

the parameters of non-linearity α and k_o are assumed to be constant with respect to depth. The system (1) is solved by

$$\ln C_2 \alpha S_1 + \alpha S_1 - \frac{C_1}{\alpha S_1} = -k_0 x, \quad \ln \frac{\alpha S_2}{C_1 C_2} + \alpha S_2 - \frac{C_1}{\alpha S_2} = k_0 x. \qquad (4)$$

and the relation $S_1S_2 = C_1/\alpha^2$ can be derived additionally from (1), stating that the product of two oppositely directed fluxes is constant at any depth. Hence the reflection coefficient R is obtained by

$$R = \frac{(1-r)C_1}{\alpha S_0 A} + r. \qquad (8)$$

and the transmission factor T by

$$T = \frac{1-r}{\alpha S_0} \sqrt{\frac{C_1}{r}} \qquad (9).$$

On the basis of these formulas the light field was studied inside and outside the medium. For the region where k_o is positive R and T are calculated by

$$R = r + \frac{(1-r)^2 r \exp(-2k_0 l)}{1 - r^2 \exp(-2k_0 l)}, \quad T = \frac{(1-r)^2 \exp(-k_0 l)}{1 - r^2 \exp(-2k_0 l)} \qquad (10)$$

for the condition $\alpha S_0 \ll 1$, and by

$$R = \frac{2r}{1+r} - \frac{2r}{\alpha S_0 (1+r)^2} k_0 l,$$
$$T = \frac{1-r}{1+r} - \frac{1}{\alpha S_0} k_0 l \qquad (11)$$

for the condition $\alpha S_0 \gg 1$. For the region of negative values of k_0,

$$R = \frac{2\alpha S_0 k_0 l r - 2r(1-r)(\alpha S_0)^2 - r(k_0 l)^2}{\alpha S_0 [2k_0 l r - \alpha S_0 (1-r^2)]},$$
$$T = \frac{(1-r^2) k_0 l \alpha S_0 - (1-r)^2 (\alpha S_0)^2 - r(k_0 l)^2}{\alpha S_0 [2k_0 l r - \alpha S_0 (1-r^2)]} \qquad (14)$$

holds for high luminances. At high values of r the energy density distribution in the plate is virtually constant. At small values, this distribution has a minimum in the interior of the plate which vanishes if $r \rightarrow 1$. There are 4 figures.

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